SOCIO-DEMOGRAPHIC FEATURES AND RISK FACTORS ASSOCIATED WITH SUSPECTED CASES OF TICK-BORNE RELAPSING FEVER IN NORTHERN BORNO STATE NIGERIA

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CERTIFICATION

This dissertation entitled Socio-Demographic Features And Risk Factors Associated With Suspected Cases Of Tick-Borne Relapsing Fever In Northern Borno State Nigeria by Idris Jibrin Manu meets the regulations governing the award of the degree of Masters in Field Epidemiology of Ahmadu Bello University and is approved for its contribution to knowledge and literary presentation.

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ATTESTATION

I declare that the work in this dissertation entitled Socio-Demographic Features And Risk Factors Associated With Suspected Cases Of Tick-Borne Relapsing Fever In Northern Borno State Nigeria has been performed by me in the Department of Community Medicine under the supervision of Dr Junaidu Kabir and Prof. J.K.P. Kwaga. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at any university.

IDRIS JIBRIN MANU	_____	_____
Name of student	Signature	Date

DEDICATION

This work is dedicated to my dear father, late Mai-anguwa Idrissa Seri and lovely mother, late Adama Idris (Adda).

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TABLE OF CONTENTS

Title page - - - - - - - - - i

Certification - - - - - - - - - ii

Attestation - - - - - - - - - iii

Dedication - - - - - - - - - iv

Acknowledgement - - - - - - - - v

Table of contents - - - - - - - - vi

List of tables - - - - - - - - x

List of figures - - - - - - - - xi

List of appendices - - - - - - - - xii

List of acronyms - - - - - - - - xiii

Summary - - - - - - - - xiv

Chapter One - - - - - - - - 1

1.0 Introduction - - - - - - - - 1

1.1 Background - - - - - - - - 1

1.2 Problem statement - - - - - - - 2

1.3 Justification - - - - - - - - 3

1.4 General and Specific objectives - - - - - - 4

1.4.1 General objectives - - - - - - - 4

1.4.2 Specific objectives - - - - - - - 4

Chapter Two - - - - - - - - 5

2.0 Literature review - - - - - - - - 5

2.1 The organism *Borrelia* - - - - - - - 5

2.2 Cultivation of *Borrelia* - - - - - - - 6

2.3 Epidemiology of Tick-borne Relapsing fever Borrelia organisms - 6

2.4 Tick vector *Ornithodoros* - - - - - - 7

2.5 Tick bite and transmission of relapsing fever - - - - 8

2.6 Borreliosis in animals - - - - - - - 10

2.7 Borreliosis in humans - - - - - - - 11

2.7.1 Lyme diseases - - - - - - - 11

2.7.2 Tick-Borne relapsing Fever - - - - - - 12

2.7.2.1 Diagnosis of Tick-borne Relapsing Fever - - - - 14

2. 7.2.2 Treatment and prevention/control - - - - - 15

2.7.3 Demographic features of Tick-borne Relapsing Fever - - - 16

Chapter Three - - - - - - - - 19

3.0 Methodology - - - - - - - - 19

3.1 Study area - - - - - - - - 19

3.2 Study design - - - - - - - - 20

3.3 Study population - - - - - - - - 20

3.3.1 Inclusion criteria for participants from referral hospitals - - 20

3.3.2 Exclusion criteria for participants from communities - - 20

3.3.3 Inclusion criteria for participants from communities - - - 20

3.3.4 Exclusion criteria for participants from communities - - - 20

3.4 Ticks - - - - - - - - - 21

3.4.1 Inclusion criteria for ticks - - - - - - 21

3.4.2 Exclusion criteria for ticks - - - - - - 21

3.5 Sample size determination - - - - - - 21

3.6 Sampling technique - - - - - - - 22

3.6.1 Community sampling - - - - - - - 22

3.6.2 Hospital respondents - - - - - - - 23

3.6.3 Sampling of ticks - - - - - - - 23

3.7 Study instrument - - - - - - - 23

3.8 Data collection methods - - - - - - - 24

3.8.1 Hospital and community survey - - - - - 24

3.8.2 Ticks - - - - - - - - - 24

3.9 Data management - - - - - - - 24

3.9.1 Statistical analysis - - - - - - - 24

3.9.2 Tick preparation for collection of haemolymph - - - 24

3.9.3 Laboratory analysis - - - - - - - 25

3.9.4 Giemsa staining procedure - - - - - - 25

3.10 Ethical consideration - - - - - - 25

3.11 Limitation - - - - - - - - 25

Chapter Four - - - - - - - - 27

4.0 Results - - - - - - - - 27

4.1 Demographic characteristics of participants from communities - - 27

4.2 Analysis of exposure factors among participants from communities - 37

4.3 Demographic characteristics of participants from referral hospitals - 44

4.4 Result of identification of ticks and evaluation for carriers of Borrelia species 56

Chapter Five - - - - - - - - 57

5.0 Discussion - - - - - - - - 57

Chapter Six - - - - - - - - 63

6.0 Conclusion and recommendation - - - - - - - 63

6.1 Conclusion - - - - - - - - 63

6.2 Recommendations - - - - - - - - 64

References - - - - - - - - 65

Appendices - - - - - - - - 72

LIST OF TABLES

Table	Title	Page
Table 4.1	Distribution of study group by LGA	28
Table 4.2	Distribution of study group by sex among community participants	29
Table 4.3	Occupation of community respondents.	33
Table 4.4	Distribution Of self-reported fever among community respondents	34
Table 4.5	Tick infestation in the various Communities	35
Table 4.6	Tick infestation of places where people rest in the afternoon	36
Table 4.7	Keeping of animals as an exposure factor for tick infestation	38
Table 4.8	Tick Infestations as an exposure factor for tick bite	39
Table 4.9	History of tick bite as an exposure factor to history of fever	40
Table 4.10	Risk factors for tick infestation, tick bite and Fever	41
Table 4.11	Unconditional Logistic regression For risk factors of Tick infestation	42
Table 4.12	Unconditional Logistic regression For risk factors of Tick bite	43
Table 4.13	Age and sex distribution of respondents, UMTH and USMH	45
Table 4.14	Age distribution of hospital respondents	46
Table 4.15	Frequency of self -reported fever in a year by age group	49
Table 4.16	Respondents reporting having received treatment for their feverish condition	50
Table 4.17	Keeping of animals as an exposure factor for tick infestation	53
Table 4.18	Presence of a tick in the environment as an exposure factor for tick bite	54
Table 4.19	Risk factors for recurrent fever in hospital patients	55

LIST OF FIGURES

Figure	Title	Page
Figure 4.0	Distribution Of respondents by occupation and Hospital	48
Figure 4.1	Keeping of animals by respondents from UMTH and USMH	52

LIST OF APPENDICES

Appendix 1:	*Borrelia* species associated with diseases of humans and animals	72
Appendix 2:	Map of Nigeria showing sahelian zone of Nigeria	73
Appendix 3:	Map of Nigeria showing Borno State	74
Appendix 4:	Map of Borno Showing the three senatorial districts	75
Appendix 5:	Map of the study site	76
Appendix 6:	Incubation of *Ornithodoros Moubata*	77
Appendix 7:	Preparation of hemolymph smear	78
Appendix 8:	Hand picking of *Ornithodoros moubata* from resting places	79
Appendix 9:	Thatched hut used by the communities as resting places in the Afternoon	80
Appendix 10:	*Ornithodoros moubata* in burrows and crevices of a tree	81
Appendix 11:	Photograph of *Ornithodoros moubata* (ventral side)	82
Appendix 12:	Engorged *Ornithodoros moubata* (dorsal aspect)	83
Appendix 13:	*Ornithodoros moubata* Hemolymph smear (Giemsa stained X100)	84
Appendix 14:	Questionnaire hospitall survey	85
Appendix 15:	Questionnaire community health centre survey	87
Appendix 16:	Permission to conduct study in UMTH	89
Appendix 17:	Ethical clearance	90

LIST OF ACRONYMS

TBRF	-	Tick-borne relapsing fever
CI	-	Confidence Interval
OR	-	Odds Ratio
LGA	-	Local Government Area
%	-	Percentage
UMTH	-	University of Maiduguri Teaching Hospital
USMH	-	Umaru Shehu Ultra-Modern Hospital
<	-	Less than
EDTA	-	Ethyl Diamine Tetra Acetic Acid
GPS	-	Global positioning System
^{0}C	-	Degrees Celsius
PCR	-	Polymerase Chain Reaction
X	-	Multiply
>	-	Greater than

SUMMARY

Tick-borne relapsing fever (TBRF) is a bacterial disease caused by *Borrelia* species which is transmitted to humans by infected ticks. The disease occurs worldwide. In West Africa, geographical distribution of *Borrelia* is classically limited to the Sahel and Saharan regions; there are no documented cases of the disease in Nigeria. This study is a response to a report of suspected TBRF in Borno state. The aim is to determine demographic features and risk factors associated with suspected cases of TBRF in northern Borno State Nigeria. A cross-sectional study was carried out in four community health centres and two referral hospitals using an interviewer administered questionnaires to obtain demographic information. One hundred samples of tick were collected from resting places in livestock markets, hemolymph smear were stained with Giemsa stain to investigate for *Borrelia*. Questionnaires were analyzed using Epi info version 3.5.1, Winepiscope soft ware and excel spread sheet. The Ages of respondents ranged from 3-70 years, both males and females had symptoms of TBRF. Their primary occupation was farming and trading. Keeping of animals was a significant (OR = 6.56, 95 % CI 1.73-24.88) risk factor for tick infestation, while keeping of animals and sleeping outside at night (OR = 4.88, 95 % CI 1.09-21.88 and OR= 3.91, 95 % CI 1.49-10.30) were significant for tick bite. None of the 100 hemolymph smear revealed Borrelia spirochete at X100. All the four communities were infested widely with ticks. Respondents of both sexes and age groups studied were engaged in occupation that exposes them to tick bite and TBRF. The state should conduct public health campaigns on preventing tick bite and establish tick-borne borreliosis surveillance mechanism.

Key Words: *Ornithodoros, Borrelia*, risk factor, Borno State, Nigeria.

CHAPTER ONE

1.0 Introduction

1.1 Background

Tick-borne relapsing fever (TBRF) is a bacterial disease caused by *Borrelia* species transmitted to humans by infected ticks[1]. The disease occurs worldwide and has been frequently reported in Africa, Western Asia, and South Eastern Europe[2,3,4,5.] The term relapsing fever was first coined to describe the clinical disease in Edinburgh between 1843 and 1848[6]. The role of *Borrelia* in causing relapsing fever was first described by Otto Obermeier, Munch and Motschuttoffsky in 1873, 1874 and 1876 respectively[7]. The genus was later named *Borrelia* after Amedee Borrel[6,8,9] who established that *Borrelia* cause relapsing fever and is transmitted by *Ornithodoros* ticks.

Tick-borne relapsing fever has an incubation period of 3 to 18 days depending on the infective dose[10]. The symptoms of the diseases are repeating bouts of fever, chills, headache, muscle pain, joint aches and nausea that last 2-7 days, punctuated by period of apparent wellness that last for about a week. The initial symptoms are the most severe with sudden onset of high fever and severe headache. A spotted and or itchy rash may sometimes occur during this first episode of illness. The number of episodes or "relapses" ranges from two to ten and each subsequent episode is less severe than the previous one. Serious complications or death can occur if the illness is not treated, especially in the very young, elderly, and pregnant or debilitated[11].

Recurring fever is suggestive of tick-borne relapsing fever; confirmation is by blood culture, microscopy, serology and molecular techniques. The condition is frequently not

diagnosed and its true incidence is under estimated[12,13] TBRF is treated by the administration of doxycycline, tetracycline, penicillin or erythromycin in that order.

Tick-borne zoonotic diseases are characterized by an intricate set of ecological relationships between pathogen, ticks, vertebrate hosts, and humans which largely determines the prevalence, as well as spatial and temporal dynamics of the diseases. In West Africa, geographical distribution of *Borrelia* is classically limited to the Sahel (Togo, Mali, Senegal and Mauritania) and Saharan regions where the tick vector is distributed; prevalence of 8.8% in hospital setting was reported in a study carried out in Togo, the situation may be similar in Nigeria.

Borrelia has been detected in birds,[14] bats,[15] dogs,[16, 17] humans and other animals[6].

1.2 Statement of Problem

Suspected cases of TBRF were reported in 2008 in Borno state by Daily Trust Newspaper of 8th December 2008 as a big public health menace. This report was not thoroughly investigated by the veterinary or public health authorities to establish the extent of the problem, tick vector and specie of *Borrelia* responsible and other features of the epidemics. The contribution of TBRF to child and maternal mortality, or as co-infection to other conditions has not been established in Nigeria.

Agriculture including livestock production is the major source of livelihood in the Sahelian and sub-Saharan Africa. In north-eastern Nigeria there is a large population of livestock species largely raised under free range conditions and considerable population of livestock in the area are also trans-boundary from neighbouring Niger, Chad and Cameroun republics. Up to 70% of trade cattle in Nigeria actually cross the Borno -Yobe

border into markets and adjoining villages. Livestock trade is very important to the economy of the people in this region. However, tick infestation is a big menace to livestock production and marketing in the area. This is evidenced by the reportedly rampant infestation of livestock markets with ticks.

The true prevalence of TBRF is not known in this area because it has not been investigated; although it is known that domestic animals play a role in the epidemiology of this disease. Under free range conditions, livestock and humans mix freely and are also freely infested by ticks. Prevailing poor socio-economic conditions that influence housing and husbandry practices also predispose humans to tick bite. It is not known what proportion of these tick bites result into infection with TBRF causing organisms.

Borreliosis is usually investigated where there is persistent and consistent patient care. Under the hospital conditions in Nigeria it is very likely that cases of TBRF are undetected.

1.3 Justification

Tick infestation and nuisance of tick bite are bound to constitute a threat to livestock marketing, reduce economic activity and potentially threaten livelihood in the area. Occurrence of TBRF in rural communities that are already under the burden of adverse socio-economic conditions such as in North-eastern Nigeria will inevitably create frustrations due to undiagnosed and unmanaged recurrent illness, increase number of hospital visits and relatively scale-up the cost of medical expenditure of poor households. Thus, detailed epidemiological study in this area is desirable to provide necessary information on the disease that will call the attention of health authorities to an otherwise

neglected disease that afflicts and negatively impact both humans and animals in the area. This could translate into control interventions against tick infestation which could translate to greater and safer human-livestock interaction, improved livestock trading, livelihoods and food security. Hospital workers may benefit from unique field epidemiological information that could redirect diagnostic priorities and save cost of disease identification due to better information particularly when patients from TBRF high risk areas are under investigation

1.4 General and Specific objectives

1.4.1 General objective

The overall aim is to determine the socio-demographic features of suspected cases of Tick-Borne Relapsing Fever (TBRF) in communities infested with ticks and in reference hospitals within Maiduguri, Borno State Nigeria.

1.4.2 Specific objectives

1. To determine the socio-demographic features of suspected cases of TBRF in communities infested with ticks and in patients reporting to the reference hospitals.
2. To determine the proportion of suspected cases of TBRF that suffered from tick bites in communities infested with ticks and in the reference hospitals.
3. To determine risk factors of tick infestation of premises and tick bite
4. To determine the presence of *Borrelia* species in ticks infesting the communities.

CHAPTER TWO

2.0 Literature Review

2.1 The organism *Borrelia*

Borrelia is an obligate bacterium with a life cycle that alternates between arthropod vectors and mammalian hosts, which are divided into two large genetic groups, the relapsing fever *Borrelia* (*B. Hermsii, B. duttoni, B. crocidurae, B. hispanica*) and the Lyme disease related *Borrelia.*

The genus *Borrelia* belongs to the family Spirochaetaceae of the order spirochaetales. *Borrelia* species are identified based on the identity of their arthropod vector, pathogenicity for laboratory animals and their geographical distribution 1[8].

Borreliae can range from 8 to 40μ in length and 0.2 to 0.5μ in width[19,20]. They have 3 to 6, and sometimes even 10 spirals; the average number of spirals is 5 to 7. The amplitude of the spirals or "waves" averages 1μ. Borreliae have no undulating membrane, but have a contractile axial filament of protoplasmic nature covered by a periplast. This filament is said to be essential for the penetrating ability of *Borrelia*. Borreliae move back and forth over a distance of two to three times their length. Their locomotion may be corkscrew-like, wavelike, forwards and backwards; or by lateral bending and looping[20].

Borrelia is microaerophillic, but can grow anaerobically. They require long chain fatty acids for growth and produce lactic acid through glucose fermentation[21] . *Borrelia* DNA has a G+C mole content of approximately 30%. They contain a linear chromosome and numerous linear and circular plasmids[22].

Borrelia cells are helically shaped and motile, and exhibit the unique rotational motility of spirochetes powered by endoflagella. The Relapsing fever *Borrelia* has 15–30 endoflagella; whereas the Lyme disease related Borreliae have 7–11 endoflagella. The cells lack cytoplasmic tubules and the endoflagella lack sheaths.

2.2 Cultivation of *Borrelia*

Borrelia is maintained in nature by cycling through wild animals and the ticks that feed upon them. *B. duttoni* and *B. recurrentis* do not have a wild animal reservoir[23]. Borrelia could also be maintained by regular passage in susceptible laboratory animal or propagated in the chorioallantoic membrane of developing chick embryo[18].

Artificial media for the cultivation of Borrelia includes Kelly culture media A, B and C, fortified Kelly's medium, Barbour-Stoenner-Kelly II (BSK II) and BSK-H.

2.3 Epidemiology of Tick-borne relapsing Fever

Relapsing fever *Borrelia* is transmitted by a bite of the vector tick or louse. Ticks transmit the organisms by saliva or coxal fluid during nocturnal feeding on an animal or human host. Other forms of transmission include transplacental infection, accidental infection of laboratory workers[24] and transfusion of infected blood[18]. The epidemiology of TBRF *Borrelia* is dependent on the tick vector, infectivity of *Borrelia,* natural host (often wild rodents), and on the possibility of contact between man and the vector.

Infection occurs when humans sleep in the vicinity of infected *Ornithodoros* ticks. The ticks are nocturnal feeders and very sedentary, living within a radius of 30m, further displacement being due to human action. Ticks can remain infective for several years

even without feeding, some can transmit the infection to their offspring and some transmit *Borrelia* during copulation[18].

There is an extraordinary geographical variation of *Borrelia* and their *Ornithodoros* tick even within one species, with high tick-Borrelia specificity. Owing to modern travel, relapsing fever can be found outside its distribution area, making the diagnosis still more difficult (Appendix 1).

The distribution of *Borrelia* in humans varies; *B. recurrentis* predominates in females (60%) while TBRF predominates in males (60%). It is not due to sex preference by the organism but probably due to occupational characteristics of the disease[18]. Highest case fatality rates are recorded at the height of epidemics of Louse Borne Relapsing Fever. In TBRF, case fatality rates differ from one geographic complex to another (0-8%). Mortality rate is higher in small children and pregnant women[25].

2.4 Tick Vector *Ornithodoros*

Ticks are currently considered to be second only to mosquitoes as vectors of human infectious diseases in the world. Each tick species has preferred environmental conditions and biotopes that determine the geographic distribution of the ticks and, consequently, the risk areas for tick-borne diseases. This is particularly the case when ticks are vectors and reservoirs of the pathogens. Ticks are obligate hematophagous arthropods that parasitize every class of vertebrates in almost every region of the world[26].

Ticks propagating human relapsing fever belong to the Argasidae (soft tick), never to the Ixodidae (hard tick). *Ornithodoros* ticks live in burrows of rodents and other animals, in

caves, dugouts and trenches infested with rodents, and in human and animal habitats with mud floors. Some feed on animals, including man, indiscriminately; others bite only one or a few species. The feeding takes about 20 to 30 min, or 1 hr or longer, according to the species of the tick. Some produce local analgesia, whereas the bite of others is very painful. Those ticks which are vectors of relapsing fever organisms attach themselves to their hosts for only a short time, usually for less than 1 hr, and their bite is seldom painful. Some of them are night feeders, and a single individual may infect a different person or animal at each feeding.

Ornithodoros ticks may take up blood equal to two to six times their own weight. While they are feeding, saliva reaches the capillaries opened by the bite. Toward the end of feeding, contents of the gut are evacuated and many ticks excrete coxal fluid. This coxal fluid may be quite voluminous, or only a drop, or may not appear at all while the tick is in contact with its host[27].

The Borreliae are passed to the eggs of the infected female tick, but not all larvae will be infested[28]. Nevertheless, this creates a reservoir of *Borrelia* in the tick population. The range of transovarian propagation varies with the species of the tick: from 0.29% in *O. hermsii* to 100% in *O. turicata*[29].

2.5 Tick bite and transmission of relapsing fever

Microbial agents that are transmitted by blood-feeding arthropods cause significant morbidity, mortality, and economic loss throughout the world[30]. The importance of tick-borne diseases for humans and companion animals is measured by morbidity and mortality, the diseases transmitted by ticks to livestock are an additional major constraint

to animal production predominantly in subtropical areas of the world[31]. Tick-borne diseases were ranked high in terms of their impact on the livelihood of resource poor farming communities in developing countries[32, 33].

Although mosquitoes surpass ticks as vectors of public health importance, ticks transmit the greatest variety of microbial pathogens of any arthropod vector including established, emerging, and resurging infectious agents[34,35]. Ticks and tick-borne diseases affect animal and human health worldwide and are the cause of significant economic losses. Approximately 10% of the known 867 tick species act as vectors of a broad range of pathogens of domestic animals and humans and are also responsible for damage directly due to their feeding behaviour[36].

Diseases transmitted through tick bites include Tick-borne relapsing fever, Lyme disease, tick-borne encephalitis etc. Ticks transmit diseases to their host during feeding through saliva or coxal fluids. Their saliva contains a complex mixture of pharmacologically active molecules that potentiate transmission of these pathogens by modulating host immune defences, itch responses, and hemostasis[37, 38, 39]. The host immunity is enhanced following repeated tick exposure and progressively reduces the ability of each subsequently attached tick to suppress the effects of the host immune response[40,41]. Development of acquired resistance to tick infestation depends upon the species of tick, host species, and history of prior exposure to tick feeding[41,38]. Humans exhibit an immune response to tick bites as evidenced by local redness and itching at the bite site and the development of antibody against specific tick salivary proteins [(42)]. Those who experience repeated tick exposure and persistent itch from tick bites have a decreased risk of developing disease[43].

Because of the unusually high prevalence and diversity of pathogens occurring in ticks, human exposure to ticks presents a serious public health risk. An overall annual incidence of 80,000 tick bites was estimated for the population of Westchester County in a study conducted by Durland Fish and James E. Childs in 2009[44].

Multiple tick bites are common in such highly endemic areas. A study on clinical outcome of persons receiving a tick bite revealed that 18% of patients received a second tick bite within 6 weeks[45]. Increased human contact to ticks will most certainly result in increased incidence of human infections.

2.6 Borreliosis in animals

Borrelia Borgdorferi, the cause of Lyme disease in humans also cause disease in dogs, horses, cattle, and cats, while many wildlife mammals and birds become infected and serve as reservoirs for tick infection [(46,47).] *B. anserina* is pathogenic for birds (chickens, turkeys, ducks.) and causes a disease called avian borreliosis or spirochaetosis. It is transmitted from bird to bird by ticks of the genus Argas and Ornithodoros.

Early investigations of *B. gallinarum* by Amedee Borrel were the reason that this genus now bears its name[48.] The impact of avian borreliosis upon its host might be associated with mortality[49].

Probably, the major advantage to the spirochetes for being able to infect avian hosts is the opportunity for dispersal over significantly wider geographical regions that could be achieved through arthropod vectors alone. *Borrelia* believed to resemble *Borrelia lonestari* has been detected in *Carios capensis*, a soft tick associated with brown pelicans in Carolina[50]. Similarly, *Carios sawaii* ticks have been found to carry *Borrelia*[51].

2.7 Borreliosis in humans

Borrelia organisms pathogenic to man cause two main diseases, Lyme disease and relapsing fever. Lyme disease is the most prevalent arthropod-borne disease in the United States. It is caused by *Borrelia burgdorferi* sensu lato genogroup[52]. Members of the group are maintained in nature and transmitted to humans by ticks of the genus *Ixodes*. Lyme disease affects all age groups and may involve the skin, joints, nervous system, and the heart[53].

Relapsing fever in man is also known as tick fever, gharib gez (Iran), carapata (Africa), Kimputu, gorgoya (south America), bilous typhoid, fowl nest fever (China) and vagabond fever (spain)[54]. Relapsing fever in man is divided into Louse-Borne Relapsing Fever which is usually epidemic in nature and Tick-borne relapsing fever which is endemic in affected areas. Louse-Borne Relapsing Fever is usually connected with overcrowding, poor housing, under nourishment, lack of cleanliness and little change of clothing[55].

2.7.1 Lyme disease

Lyme disease is a tick-borne disease first described in 1975. The etiologic agent of Lyme disease is *Borrelia burgdorferi.* Tick bite leads to transmission of *B. burgdorferi* causing an erythematous skin rash in a few days along with a transient bacteremia leading to severe neurologic symptoms or polyarthritis. The disease may progress in three distinct stages that are characterized by the development of a pathogenic rash, and cardiac, neurologic and oligoarticular sequel[56]. f antibiotic therapy is initiated early a cure is usually achieved. However, late antibiotic administration (e.g. penicillin or tetracycline) is often ineffective.

Lyme disease is geographically focal with approximately 90% of the human case reports originating from 137 counties in the north-eastern and upper-Midwestern United States[57]. In the north-eastern United State, human exposure is primarily peridomestic in nature[58], but in the Upper-Midwest, exposure is more frequently associated with recreational activities[59].

The vast majority of body fluid or tissue samples from patients with Lyme disease do not yield spirochetes on culture. It is diagnosed by detection of serum antibodies to *B. burgdorferi*. However, acutely antibodies may not occur in detectable titre, making early diagnosis difficult. Late diagnosis may lead to ineffective treatment. Many patients are unaware of having had a tick bite or a rash. Control and prevention of Lyme disease is basically tick control, use of acaricides, vaccination and prevention of tick bites. In Lyme disease is very rare, the important disease caused by Borrelia in Africa is relapsing fever[18].

2.7.2 Tick-Borne Relapsing Fever

Tick-borne relapsing fever is an acute infectious disease caused by spirochetes of the genus *Borrelia*. It is transmitted by the bite of infected ticks of the genus *Ornithodoros*[18]. Infection is followed by an incubation period of 3 to 18 days and sometimes even more depending on the infective dose. Initial attack starts with the sudden onset of shaking chills with a rapidly rising temperature. The fever is often remittent, occasionally intermittent and rarely continuous. The patient often complains of headache, backache, muscle pain, arthralgia and abdominal pain. Nausea, cough, dizziness, epistaxis and sometimes vomiting[60]. Clinical examination may be normal or reveal tachycardia, tachypnoea, jaundice, purpura, tenderness over the liver, and the spleen with or without

splenomegaly, an erythematous rash, and meningismus [61]; there may be lethargy delirium and agitation[61].

The initial attack averages 12 hours to 17 days and terminates with a crisis. This is followed by an apyrexial interval that varies from 1-63 days. This period is afebrile but often not asymptomatic, with persisting malaise or with the same symptoms as before the crisis but less intense[54].

One or more relapses may be experienced if untreated. Each successive relapse is of decreasing length and magnitude, although successive paroxysms can become more severe[27]. A progressive decline of the general condition with extreme weakness and weight loss can occur if successive relapses occur without adequate treatment[62].

Liver damage is reflected by rise in serum bilirubin and transaminases. Alkaline phosphatase is only slightly raised even in severely jaundiced patient.

Purpura and epistaxis are the most common sign of abnormal bleeding. Purpura varies from petechial rashes which do not affect prognosis to extensive echymoses and develops early in the first attack, never appearing during relapse. Petechia is preferentially located on the trunk. In epistaxis, the nasal mucosa appears hyperemic with diffused oozing of blood[63]. Haemoptasis, haematemesis, bloody diarrhoea, subarachnoid and cerebral haemorrhages, splenic rupture and retinal haemorrhages are other haemorrhagic phenomenon encountered[64].

Petechia is due to thrombocytopenia with a direct effect of the numerous spirochetes on endothelial competence and platelets dysfunction. Signs of meningitis and sometimes a psychotic behaviour with delirium and hallucinations follows crisis and may persist for several days.

There is a risk of 33% of interruption of pregnancy with a perinatal mortality of 16%. Congenital borreliosis has been demonstrated by[65, 66].

2.7.2.1 Diagnosis of Tick-borne relapsing fever

A history of a relapsing febrile illness as well as illness with jaundice, skin rashes, haemorrhages or thrombocytopenias are differentials. In areas with low endemicity of TBRF or areas outside the endemic areas, simultaneous occurrence of TBRF with malaria, typhoid fever, and rickettsiosis or Kala- azar is possible. Relapsing fever should be considered in patients with suspected malaria who do not have parasitemia on peripheral blood smears[67,68].

The diagnosis is established by microscopy by identifying spirochetes on a thick and thin smear of Peripheral blood. The sensitivity of a blood smear is approximately 70% -80% when the patient is febrile, but less than 5% during an afebrile period[69,70]. Sensitivity can be increased by repeating smears, staining fixed smears with acridine orange[71] or calling for dark-field or phase-contrast microscopy of wet mount preparations[72]. Culture on Kelly's media[30] or by inoculation of a laboratory animal can also improve sensitivity and specificity, but neither are routinely available in clinical laboratories. Organisms may occasionally be identified in urine or cerebrospinal fluid[44].

Serological tests have a limited value for diagnosis due to the frequent false positive reactions and cross-reactivity with other *Borrelia* species, but a rising titer may help to establish a retrospective diagnosis. Serological GlpQ assays have been used for diagnosis of Tick-borne relapsing fever[73]. However, serological methods could not differentiate between active and past disease.

Molecular analysis is the most sensitive diagnostic method, and has the advantage of allowing species identification by sequencing [74, 70] or on the basis of restriction patterns[75]. This type of analysis can also be performed on frozen blood or samples kept for several days at 4^0C, and three sequences of genes *fla*B, *glp*Q and 16S rRNA genes[74,70].

2.7.2.2 Treatment and Prevention/Control

Public education concerning the risks involved in entering endemic areas of the disease, combined with preventive measures are effective in reducing the number of TBRF cases. It is recommended to spray shoes and the trouser bottoms with a repellent. Avoidance of long stays in sites colonized by ticks reduces the opportunities for ticks to identify the host. Sleeping in such sites must be avoided. If it is necessary to stay at archaeological or similar sites for an extended period, it is necessary to monitor whether the place is infested with ticks, and to spray the site with insecticides[76].

For single exposures, the classic pre-exposure prophylaxis based on doxycycline is used; it can be similarly used for post-exposure prevention[77]. Oral tetracycline or doxycycline for 5-10 days is generally considered the treatment of choice[78], the effective substitute is

erythromycin and it should be used in children, pregnant women and patients with allergies to tetracycline or doxycycline[72].

Delayed clearance of organisms from blood and increased rates of relapse occur with penicillin therapy. Rare relapses have been reported with tetracyclines[79]. A longer duration of therapy may be warranted for patients with high-level Spirochetemia or a complicated course. Mortality is rare for appropriately treated patients[66,72].

The Jarisch-Herxheimer reaction, characterized by fever, chills, tachycardia, hypotension and leukopenia, develops in some patients, usually within 2 hours of initiating antimicrobial therapy. The onset of this reaction correlates temporally with clearance of spirochetes from the blood stream. The pathophysiology of this sepsis-like syndrome involves the release of opioids or cytokines such as tumour necrosis factor, interleukin 6 and interleukin 8 [80,81]. This reaction, which can be fatal, has been observed in patients treated with a variety of antimicrobial agents[65].

Treatment is supportive. Initiating therapy during an afebrile period may reduce the likelihood or severity of this reaction. Premedication with antipyretics or anti-inflammatory drugs does not ameliorate this reaction[76].

2.7.3 Demographic features of Tick-Borne Relapsing Fever

Ornithodoros ticks are found in the restricted habitats of their hosts and rarely move very far. They can be found in loose, dried soil of dwellings, cracks and crevices in mud-walled animal shelters, animal burrows and animal resting places, and under tree bark[82,83].

Relapsing fever *Borrelia* is transmitted through saliva or coxal fluid during nocturnal feeding on an animal or human host. Other forms of transmission include transplacental infection, accidental infection of laboratory workers[84] and transfusion of infected blood[85].

Infection occurs when humans sleep in the vicinity of infected *Ornithodoros* ticks. The ticks are nocturnal feeders and very sedentary, living within a radius of 30m, further displacement being due to human action. There is an extraordinary geographical variation of *Borrelia* and their *Ornithodoros* tick even within one species, with high tick-borrelia specificity. Owing to modern travel, relapsing fever can be found outside its distribution area, making the diagnosis still more difficult (See table 1.0).

The distribution of *Borrelia* in humans varies; *B. recurrentis* predominates in females (60%) while TBRF predominates in males (60%). It is not due to sex preference by the organism but probably due to occupational characteristics of the disease[86]. Highest case fatality rates are recorded at the height of epidemics of Louse Borne Relapsing Fever. In TBRF, case fatality rates differ from one geographic complex to another (0-8%). Mortality rate is higher in small children and pregnant women[61.]

In a prospective study carried out by M'hammed *et al* 2009[87] in Morocco, *Borrelia* Species were detected in 17.5% of the patients in 2005 and in 22.9% of 70 patients in 2006 (mean prevalence rate 20.5%). The patients had not travelled outside Morocco.

M'hammed *et al* 2009[87] reported that the most common signs and symptoms associated with fever were chills (88%), myalgia (61%), and gastrointestinal disorders, such as diarrhoea and vomiting (54%). Fifteen percent of the patients reported >1 relapse.

Patients did not report any tick bites. All patients were successfully treated with doxycycline (100 mg/day for 7 days). Only 2 patients had a diagnosis of TBRF on the basis of microscopy.

CHAPTER THREE

3.0 Methodology

3.1 Study Area

The study was carried out in Borno state, Nigeria. Borno state lies within Latitude 10 -14^0 North, and longitude 11.30 -14.35^0 East and is located in the North-East geopolitical zone of Nigeria. Borno state has an estimated population of 4.7 million people. It shares borders with Yobe, Adamawa and Gombe states and international boundaries with the republics of Niger, Chad and Cameroon. The state has 27 Local Government Areas (LGAs). Borno state is located in the Sahelian vegetation zone which is a transitional eco-region of semi-arid grasslands and shrubs lying between Sudan savannah to the south and the Sahara desert to the north.

Four communities with livestock markets (Kukawa, Baga, Damasak and Gubio) representing 3 local governments from Borno north senatorial district and two hospitals; University of Maiduguri Teaching Hospital (UMTH) and, Umaru Shehu Ultra-modern Hospital Maiduguri were used for the study.

The two hospitals enrolled for the study were University of Maiduguri Teaching Hospital (UMTH) and Umaru Shehu Ultra-modern Hospital Maiduguri (USMH). UMTH is a tertiary hospital located along Bama road in Maiduguri. It serves as a referral centre to all the states in the north eastern geopolitical region of Nigeria, and to neighbouring countries of Niger, Cameroun and Chad. Apart from clinical services, it also offers diagnostic services and offer trainings for many health related disciplines at both undergraduate and postgraduate levels. USMH is a secondary health facility providing clinical, referral, and trainings services to individuals and health institutions both within

and outside Maiduguri city. It is located in Bulumkutu, along Jos road within Maiduguri city.

3.2 Study Design

A descriptive Cross-sectional study design was adopted for the investigation

3. 3 Study population

Study population were derived from outpatients in four community health centres and two referral hospitals.

3.3.1 Inclusion criteria for participants from referral hospitals

Patients reporting to the hospitals with fever or a history of recurrent fever were included in the study. Recurrent fever was defined as fever that is characterized by episode of high fever, chills, headache, muscle pain and nausea that recur every week or ten days for several months.

3.3.2 Exclusion criteria for participants from referral hospitals

Patients refusing to participate were excluded from the study.

3.3.3 Inclusion criteria for participants from communities

Any community member with fever or history of recurrent fever and is willing to participate in the study was included.

3.3.4 Exclusion criteria for participants from communities

Children whose parent did not consent and adults that were not willing to participate in the study were excluded.

3.4 Ticks

Soft ticks found in the selected communities.

3.4.1 Inclusion criteria

Soft ticks found in animal stables, livestock markets and resting places were included in the study.

3.4.2 Exclusion criteria

Ixodes (hard) ticks were not included in the study.

3.5 Sample Size determination

The minimum sample size was determined using the formula

$$n = \frac{Z^2 \times (p)\,(q)}{(d)^2}$$

Where:

- $Z1-\alpha/2 = 1.96$ with 95% confidence interval
- d is "desired precision" (the desired width of the confidence interval) (± 5%).
- p = Expected probability of variable of interest.
- 10% attrition (non-response) rate was allowed to obtain the minimum sample size required.

a. Human sample: With a prevalence of 7.5 %, reported in a community survey[88], and 8.8% in hospital survey[89] the minimum sample size of 253 was considered. (118 for community + 135 for hospital)

For communities: Z = 1.96, p = 0.075, q = 0.925, d= 0.05

$$= \frac{(1.96)^2 \times (0.075) \times (0.925)}{(0.05)^2}$$

$$= \frac{0.2665}{0.0025}$$

$$= 107 + 10.7 \text{ (10\% of 107)}$$

$$= 118$$

For hospital: Z= 1.96, p= 0.088, q = 0.912, d= 0.05

$$= \frac{(1.96)^2 \times (0.088) \times (0.912)}{(0.05)^2}$$

$$= \frac{0.3083}{0.0025}$$

$$= 123 + 12.3 \text{ (10\% of 123)}$$

$$= 135$$

Total sample size = 118 + 135 = 253

b. Ticks: 100 tick samples (convenient sample)

3.6 Sampling Technique

3.6.1 Community

Two Communities with livestock markets (Kukawa and Baga) representing Kukawa Local Government and one community each i.e. (Gubio and Damasak) with livestock markets representing Gubio and Mobbar LGAs were selected respectively. The first participant was selected randomly after which each fifth patient that had history of

repeated episode of fever was selected and recruited for the study. A Questionnaire was administered to each participant.

3.6.2 Hospital respondent

Participants were selected as they came to the hospital for medical attention. The first participant was selected randomly, after which every third patient that complained of having repeated episode of fever was selected and questionnaire administered.

3.6.3 Ticks

Ticks were hand-picked from resting places, animal stable, burrows and livestock markets.

3.7 Study Instruments

1. Structured Questionnaire**:** A structured questionnaire was pretested before the onset of the study.
2. Glass slides: Hemolymph smear were made, fixed with methanol and stained with Giemsa stain on glass slide.
3. Plastic containers: Ticks were stored in plastic containers before processing for.
4. Giemsa stain, test tube holders/rack, forceps Ice pack, Storage/transport containers (carriers, coolers).
5. Clinical thermometer: Clinical thermometer was used to obtain axillary temperature of respondents.
6. Light microscope: Giemsa stained glass slides were viewed at X100 magnification using.

3.8 Data Collection Methods

3.8.1 Hospital and community survey

For participants in the two referral hospitals, pretested questionnaire was administered to each eligible participant as they come to the hospital. Information on demography, history of fever and association with animals was captured using the questionnaire. For participants from the communities, another pretested standardized questionnaire was administered to collect data on demography, history of fever and living conditions.

3.8.2 Tick sampling

Ticks were hand-picked from livestock markets, resting places and burrows of trees. Ticks were stored in a moist soil alive before testing.

3.9 Data Management

3.9.1 Statistical analysis

Questionnaire derived results was entered into Epi Info epidemiological software, Win Episcope and Excel spread sheet for analysis. All analysis were at 95 % confidence interval

3.9.2 Tick preparation for collection of haemolymph

Ticks were washed with normal saline and dried using a tissue paper. The ticks were distributed in to a plastic container packed with a cotton wool and labelled 1-100 after which they were incubated at 33 ^{0}C for 5 days.

Glass slides were cleaned with 70% alcohol and labelled 1-100 using a diamond pencil. The legs of each tick were cut at the base using a scissors and hemolymph smear was

made from each. Glass slides were air dried and fixed in absolute alcohol for 3 minutes. Glass slides were dried before staining.

3.9.3 Laboratory Analysis

Ticks were grossly identified and microscopy (Giemsa stains) of hemolymph smears were viewed at X100 magnification

3.9.4 Giemsa staining procedure

The glass slides were stained as described by [59]. Briefly glass slides were placed; smear downwards, in a container. Giemsa stain was poured into the container and covered with a lid (inverted method of staining). The smear was left to stain for 30 minutes and the smear was rinsed with buffered water. The back of the glass slides were wiped clean and placed in a draining rack for the smear to air-dry. The smears were examined microscopically at X100 magnification for *Borrelia* spirochetes.

3.10 Ethical Considerations

Permission was obtained from Borno State Ministry of Health, University of Maiduguri Teaching Hospital and from each local government area. Approval from Ethical Committee, University of Maiduguri Teaching Hospital was granted. Parental consent from parents of children less than 13 years of age and informed consent from each participant was obtained. Copies of these documents are attached as appendices.

3.11 Limitations

1. The security situation in the study area affected sampling methods; participants were selected as they come into a health facility. This affected the demographic distribution of participants and access into households. Data was based on

responses from the participants and not physical observation of households. Ticks were collected from crevices and burrows of resting places (thatched huts and trees) in livestock markets.

2. Sex and stage of development of ticks were not considered. Data were not presented to reflect this information.
3. Ticks were collected during dry season of the year, therefore effect of season on the behaviour of ticks and hence *Borrelia* cannot be explained by the study.

The study will not be able to establish infection with *Borrelia* or development of Tick-borne Relapsing Fever as a result of tick bite

CHAPTER FOUR

4.0 Results

4.1 Demographic characteristics of participants from communities

The total respondents from Gubio were 33 (25.8%), Kukawa 48 (37.5%) and Mobbar were 47 (36.7%). Male were 81/128 (63.3%) and female 47/128 (36.7%) (Table 4.1).

In Gubio, 23 out of 33 respondents (69.7%) 33 were male, while a total of 26 (54.2%) out of the 48 respondents from Kukawa were male. In Mobbar, 32 (68.1%) of the respondents were male and 15 (31.9%) were female.

The age of female respondents ranged from 4 to 30 years. The range is 6 to 62 years in males. 51 (39.8%) of respondents are in the age group 24-33 years.

Table 4.1: Distribution of study groups by LGA

LGA	**Age group (years)**						**Total**
	4 -13	14 -23	24 -33	34 -43	44 -53	54 -63	
Gubio	1	7	19	5	1	0	33 (27.8%)
Kukawa	5	5	12	11	14	1	48 (37.5%)
Mobar	9	7	20	5	5	1	47 (36.7%)
Total (%)	15 (11.7)	19 (14.8)	51(39.8)	21(16.4)	20 (15.6)	2 (1.6)	128

Gubio had the least participants when compared to Kukawa and Mobar. Most respondents are aged between 14 and 53 years.

Table 4.2: Distribution of study group by sex among community participants

LGA	Male	Female	Total
Gubio	23	10	33 (27.8%)
Kukawa	26	22	48 (37.5%)
Mobar	32	15	47 (36.7%)
Total	81 (63.3%)	47 (36.7%)	128

More male (63.3%) than female (36.7%) participated in the study.

The common primary occupations of participants are farming, trading, civil servants, house wives, dependents and looking after animals (herdsmen) (see table 4.2).

Farmers are 41 (32.0%), traders 31 (24.2%), civil servants 27 (21.1%), dependents 15 (11.7%) while herdsmen and housewives are 7 (5.5%) each. 25 (61.0%) of farmers were aged between 24 and 43 years. Majority, 12 (80%) of respondents whose age ranged from 4- 13 years live with their parents or guardian (dependents), only 3 (20%) look after animals (herdsman). Farming was more common among male respondents 27(65.9%) than females 14 (34.1%). Male were also engaged more 19 (61.3%) in trading than females 12 (38.7%). Four (14.8%) of females were civil servants when compared to 23 (85.2%) of male civil servants. 7 female respondents were house wives, 8 (53.3%) females were dependents and 2 (28.6%) females look after animals.

Episodes of fever among respondents vary from zero to as much as more than twice in a month (see table 4.1). 19 (14.8%) of respondents had episodes of fever for as much as more than three times in a year. The frequency of self-reported fever was 25 (28.4%) among farmers, 26 (29.5%) among traders, 17 (19.3 among civil servants, 11 (12.5%) among dependents, 6 (6.8%) among herdsmen and 3 (3.4%) among housewives. 59 (67.1%) of respondents reporting fever were male, 29 (32.9%) were females. 46 (52.3%) of people who reported fever live in cemented house and, 42 (47.7%) live in huts. All the 88 (100%) respondents who reported fever were treated for fever at least once (table 4.11).

Seventy four (57.8%) of the respondents reported that they noticed ticks in their compounds (table 4.12). 36 (48.6%) of farmers, 11 (14.9%) of civil servants, 11 (14.9%)

of traders, 6 (8.1%) of dependents, and 5 (6.8%) each of herdsmen and house wives reported seeing ticks in their compounds.

Out of the 128 respondents, 125 (97.6%) reported seeing rodents in their compounds and 41(32.8%) farmers, 29 (23.2%) traders and 26 (20.8%) civil servants reported seeing rodents in theirs compounds.

The common type of houses in the area are those with zinc roofing, plastered wall and floor (cemented house type) and those with thatched roofing whose walls and floors were not plastered (Hut). 71 (55.5%) of respondents live in cemented houses while 57 (44.5%) live in houses that are not cemented (huts). Majority, 52 (73.2%) of people living in cemented houses are civil servants and farmers.

Rodents and ticks were noticed in both house types, 25 (35.2%) of people living in cemented houses and 26 (45.6%) of people living in huts reported rodents in their compounds. 27 (38.0%) of people living in cemented house and 27 (47.4%) of people living in huts reported ticks in their compounds. The presence of both rodents and ticks were reported in all the house types, 73 (57.0%) of respondents reported being bitten by ticks. The frequency of people living in cemented house that reported seeing both rodents and ticks in their compounds is 44 (62.0%), and of people living in huts is 30 (52.6%).

Sleeping outside at night is a common practice among respondents, 94 (73.4%) of them sleep outside at night. 55 (58.5%) of people sleeping outside at night were people living in cemented houses, 39 (41.5%) of people sleeping outside at night were people living in huts.

Eighty three (88.3%) of people sleeping outside at night keep animals. 39 (41.5%) of people sleeping outside at night keep their animals within their houses.

A total of 60 (63.8%) of the people sleeping outside at night have ticks in their compounds and, 93 (98.9%) of people sleeping outside at night have rodents in their compounds.

The places where people rest in the afternoon include, under a roof on a cemented floor and under a shed (see plate 4.0, 4.1). 116 (89.9%) of respondents rest under a shed and, 12 (9.4%) rest under a roof on a cemented floor (table 4.13). The distance of resting place from animal stable ranged from 20 meters to 100 meters. 82 (64.6%) of people resting outside during the day keep a distance that ranged between 20 -40 meters with their animal stable.

Table 4.3: Occupation of community respondents

Occupation of respondents	**Age group (years)**						**Total (%)**
	4 -13	14 - 23	24 - 33	34 - 43	44 - 53	54 - 63	
Farming	0	6	14	11	8	2	41 (32.0)
Herdsman	3	0	2	2	0	0	7 (5.5)
Trading	0	8	19	2	2	0	31 (24.2)
Housewife	0	0	6	0	1	0	7 (5.5)
Civil servant	0	2	10	6	9	0	27 (21.1)
Dependent	12	3	0	0	0	0	15 (11.7)
Total (%)	15	19	51	21	20	2	128

Farming and trading is the major occupation of respondents; 41(32.0%) and 31(24.2%) respectively.

Table 4.4: Distribution of self reported fever among community respondents.

Occupation	**Frequency(N=88)**
Farming	25 (28.5%)
Herdsman	6 (6.8)
Trading	26 (29.6%)
Housewife	3 (3.4%)
Civil servant	17 (19.3)
Dependent	11 (12.5%)
Total	88

Farmers and traders reported more cases of fever than any of the group. Housewives reported the least (3.4%).

Table 4.5: Tick infestation in the various Communities

S/No	Community	Tick present	Tick absent	Total (%)
1	Gubio	4	29	33 (25.8)
2	Damasak	28	19	47 (36.7)
3	Kukawa	16	5	21 (16.4)
4	Baga	26	1	27 (21.1)
	Total (%)	74 (57.8)	54 (42.1)	128

Majority (57.8%) of respondents reported presence of tick in their environment.

Table 4.6**:** Tick infestation of places where people rest in the afternoon

S/No	Place of rest in the afternoon	History of tick bite		Total
		Yes	No	
1	Cemented Floor	2	10	12 (9.4%)
2	Earth/shed	71	45	116 (90.6%)
	Total	73 (57.0%)	55 (43.0%)	128

Places of rest (earth/shed) without cemented floors had more ticks (90.6%) than cemented floors, and cases of tick bite was more common (57%) among people resting on non cemented floors.

4.2 Analysis of Exposure Factors Among participant from communities

Bivariate analysis of risk factors shows that keeping of animals was an exposure factor for tick infestation, OR was 6.76, 95% CI was 1.64-32.22 (see table 4.7). Also at bivariate level tick infestation was an exposure factor for tick bite among community members, OR was 7.96, 95% CI 3.59-17.66 (see table 4.8). History of tick bite was also an exposure factor for fever but was not statistically significant, OR was 0.53, 95% CI was 0.22-1.23 (see table 4.9). Table 4.10 summarizes the exposure factors (at bivariate level) for tick infestation, tick bite and development of fever among the community members.

Keeping of animals remained a statistically significant exposure factor for tick infestation after an unconditional logistic regression OR was 6.56, 95% CI 1.73-24.88). See table 4.11. Sleeping outside at night and keeping of animals were statistically significant exposure factor for tick bite at multivariate level (see table 4.12) OR, 3.91, 95% CI 1.49-10.30 and OR, 4.88, 95% CI 1.09-21.88 respectively.

Table 4.7: Keeping of animals by community respondents as an exposure factor for tick infestation

Presence of ticks	**Keeping of Animals**		**Total**
	Yes	**No**	
Tick present	71	3	74 (57.8%)
Tick absent	42	12	54 (42.2%)
Total	113 (88.3%)	15 (11.7%)	128

Keeping of animals is associated with presence of ticks in the environment (tick present), odds ratio is 6.76, 95% confidence interval is 1.64-32.22

Table 4.8: Tick Infestations as an exposure factor for tick bite among community respondents

Tick present in environment	History of tick bite Yes	History of tick bite No	Total
Yes	57	17	74 (57.8%)
No	16	38	54 (42.2%)
Total	73 (57.0%)	55 (43.0%)	128

History of tick bite is associated with presence of ticks in the environment, odds ratio is 7.96, 95% Confidence interval is 3.59-17.66.

Table 4.9: History of tick bite as an exposure factor to history of fever among community participants

History of tick bite	Self reported fever		Total
	Yes	No	
Yes	46	27	73
No	42	13	55
Total	88	40	128

Self reported fever is not associated with history of tick bite, odds ratio is 0.53, 95% Confidence interval is 0.22-1.23. It is not statistically significant

Table 4.10: Risk factors for tick infestation, tick bite and Fever among community participants

Variable	Odds ratio	95% Confidence Interval
Risk factors for tick infestation		
Keeping of animals	6.76	1.80-25.35
Resting on non-cemented floor	3.04	0.87-10.69
Risk factors for tick bite		
Presence of tick	7.96	3.59-17.66
Resting on non-cemented floor	7.89	1.65-37.67
Sleeping outside at night	4.25	1.84-9.82
Risk Factor for Fever		
Tick bite	0.53	0.22-1.23

Keeping of animals is significant (OR: 6.76, CI: 1.80-25.35) risk factor for tick infestation at bivariate level. Presence of ticks (OR: 7.9, CI: 3.59-17.66), resting on non-cemented floors (OR: 7.89, CI: 1.65-35.67) and sleeping outside at night (OR: 4.25, CI: 1.84-9.82) are significant risk factors for tick bite.

Table 4.11 : Unconditional Logistic regression For risk factors of Tick infestation

Risk factor	Odds ratio	CI (95%)	P-Value
Keeping of animals	6.56	1.73-24.88	0.01
Resting on non-cemented floor	2.73	0.73-10.14	0.13

Keeping of animals remained a significant risk factor for tick infestation after unconditional logistic regression.

Table4.12: Unconditional Logistic regression For risk factors of Tick bite

Risk factor	Odds ratio	CI (95%)	P-Value
Keeping of animals	4.88	1.09-21.88	0.04
Resting on non-cemented floor	5.98	0.96-36.67	0.05
Sleeping outside at night	3.91	1.49-10.30	0.01

Keeping of animals and sleeping outside at night remained significant risk factors for tick bite after unconditional logistic regression

4.3 Demographic characteristics of participants from referral hospitals

A total of 148 questionnaires were administered to the study participants in the referral hospitals made up of 56 (37.84%) males and 92 (62.16%) females (see Table 4.13).

Seventy eight (52.7%) of the respondents were from UMTH and their ages ranged from 3 - 68 years for males, and 2 -60 years for females. Thirty two (41.0%) were males, with a median age is 27.5 years, while 46 (59.0) were females, and a median age of 33.5 years (see Table 4.14).

Seventy (47.3%) respondents were from USMH and their ages ranged from 2 to 63 years in males and 3-70 years for females. Males were 24 (34.3%), with a mean age of 28.17 years and females were 46 (65.7%), and mean age was 29.54years.

The number of females in both hospitals was the same (46). Participants in the age group 2-11 years were more in USMH (8) than in UMTH (5). Whereas those in age group 32-41 were more than double (19) in UMTH than in USMH (9).

Table 4.13: Age and sex distribution of respondents, University of Maiduguri Teaching hospital (UMTH) and Umaru Shehu Ultra-Modern Hospital Maiduguri (USMH)

	Sex (N=148)		**Age Group (Age in years)**							**Total**
Hospital	**Male**	**Female**	**2 -11**	**12 -21**	**22 – 31**	**32 – 41**	**42 -51**	**52 – 61**	**>62**	
UMTH	32	46	5	13	21	19	13	6	1	78
USMH	24	46	8	14	24	9	10	2	3	70
Total	56	92	13	27	45	28	23	8	4	148

Table 4. 14: Age distribution of hospital respondents at UMTH and USMH

UMTH Age (in Years)				USMH Age (in Years)			
Sex	**Median**	**Min**	**Max**	**Sex**	**Median**	**Min**	**Max**
Male (N=32)	27.5	3	68	Male (N=24)	27	2	63
Female (N=46)	33.5	2	60	Female (N=46)	25	3	70

The Primary occupation of respondents included farming (cultivation of crops and rearing of animals), trading (buying and selling including livestock), house wife (married women who usually stay at home), civil servants (including people working in private organization such as banks), students (Quaranic schools, primary and secondary schools, and tertiary institutions), and dependent persons (Individuals who live with their parent or guardance, but are not enrolled into any form of work or schooling).

House wives were predominant in USMH i.e. 40 (27.0%), followed by students, 36 (24.3%). The least 14 (9.5%) were farmers (see Figure 4.0).

Civil servants formed the majority (28.2%) of respondents from UMTH and no respondent reported being a farmer. The majority (28.6%) of respondents from USMH were house wives, the least (4.3%) were civil servants (see figure 4.1).

There were cases of self-reported fever in which 90 (60.8%) had reported having fever at least once in the previous month, while 35 (23.65%) reported having fever more than three times in a year (see Table 4.15).

When asked about treating their fever, 110 (74.32%) of respondents said they were at different times given treatment for their feverish conditions (see Table 4.16).

The respondents had a mean axillary temperature of 36.7 ^{0}C in males and 37.1^{0}C in females. The axillary temperature ranged from 29.0^{0}C to 39.5^{0}C; the minimum of 29.0^{0}C was found among dependents and the maximum of 39.5^0 C was among farmers. The mean axillary temperature ranged from 35.58^{0}C (found among dependents) to 38.2 ^{0}C (found among farmers).

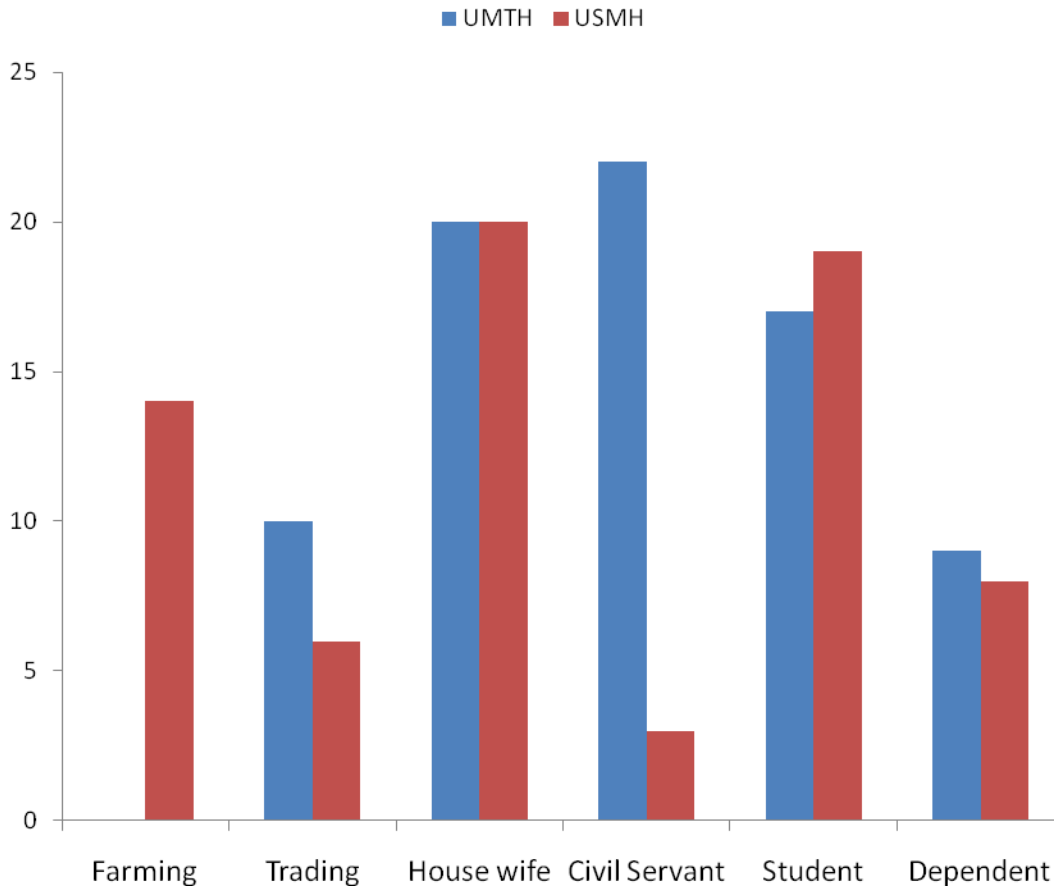


Figure 4.0: Distribution Of respondents by Occupation and Hospital.

Majority (28.2%) of the respondents in UMTH are civil servants closely followed by housewives and students respectively. None reported being a farmer.

Majority of respondents in USMH are housewives followed by students. All the farmers in the hospital study group are from USMH.

Table 4.15: Frequency of self-reported fever in a year by the various age group

Age group (Years)	No fever (No %)	Once (No %)	Twice (No %)	Three times	>Three times (No %)	Total
2 to 11 (N=13)	4 (30.8)	7 (53.8)	2 (15.4)	0 (0.0)	0 (0.0)	13
12 to 21 (N=27)	2 (7.4)	9 (33.3)	3 (11.1)	8 (29.6)	5 (18.5)	27
22 to 31(N=45)	5 (11.1)	13 (28.9)	5 (11.1)	10 (22.2)	12 (26.7)	45
32 to 41 (N=28)	0 (0.0)	9 (32.1)	2 (7.1)	7 (25.0)	10 (35.7)	28
42 to 51(N=23)	3 (13.0)	7 (30.4)	2 (8.7)	5 (21.7)	6 (26.1)	23
52 to 61 (N=8)	2 (25.0)	2 (25.00	1 (12.5)	2 (25.0)	1 (12.5)	8
>62 (N=4)	2 (50.0)	0 (0.0)	0 (0.0)	1 (25.0)	1 (25.0)	4
Total =	**18 (12.16)**	**47 (31.76)**	**15 (10.14)**	**33 (22.29)**	**35 (23.65)**	**148 (100)**

Episode of fever varied among age groups, it ranged from having no episode to as much as more than three times in a year. Many respondents within 12-51 years reported more episode than the remaining age group.

Table 4.16: Respondents reporting having received treatment for their feverish conditions

Age group (years)	Yes	No	Total
2 -11	8	5	13 (8.8%)
12-21	18	9	27 (18.2%)
22 -31	35	10	45 (30.4%)
32 - 41	24	4	28 (18.9%)
42 - 51	18	5	23 (15.5%)
52 - 61	4	4	8 (5.4%)
>62	3	1	4 (2.7%)
Total	110	38	148

More people in the age group 22-31 reported that they received treatment for the several feverish conditions they suffered. The age group 12-51 years appeared to have received treatment more than the remaining age group, with people above 62 years having the least number.

Keeping of animals by respondents was not common, only 52 (35.14%) of respondents kept animals, and more women 32(61.5%) than men 20 (38.5%) reported keeping animals (See figure 4.1). Keeping of animals was an exposure factor for tick infestation among hospital respondents (table 4.17).

The animals kept include cattle, sheep, goat, dog and poultry. House wives kept more animals 20 (38.5%) than any of the groups. Most of the animals they kept were poultry 13 (65%). Only 12 (23.1%) of the farmers kept animals. House wives associated with animals 17 (32.7%) than farmers 13 (25.0%) and any other group. Association with animals in this context means carrying out activities such as feeding of animals, grooming, cleaning their vicinity, medication or looking after them. Traders and dependents had the least association with animals, with only 5 (9.6%) and 3 (5.8%) for traders and dependents respectively.

Ticks were not common sight in the environment of the respondents. Only 33 (22.30%) of respondents reported seeing ticks in their environment with 12 (36.4%) see table (4.17), house wives and 10 (30.3%) farmers having encountered ticks. Dependents did not report seeing any tick in their environment and only 5 (15.2%) of civil servants and 3 (9.1%) each of students and traders noticed ticks in their environments. Two (12.5%) of traders, representing 66.7% of people bitten by ticks were traders. Civil servants made the remaining 33.3% of people bitten by ticks, only 3 people were bitten by ticks (see table 4.18). Risk factors for recurrent fever in among hospital respondents were not statistically significant (table 4.19).

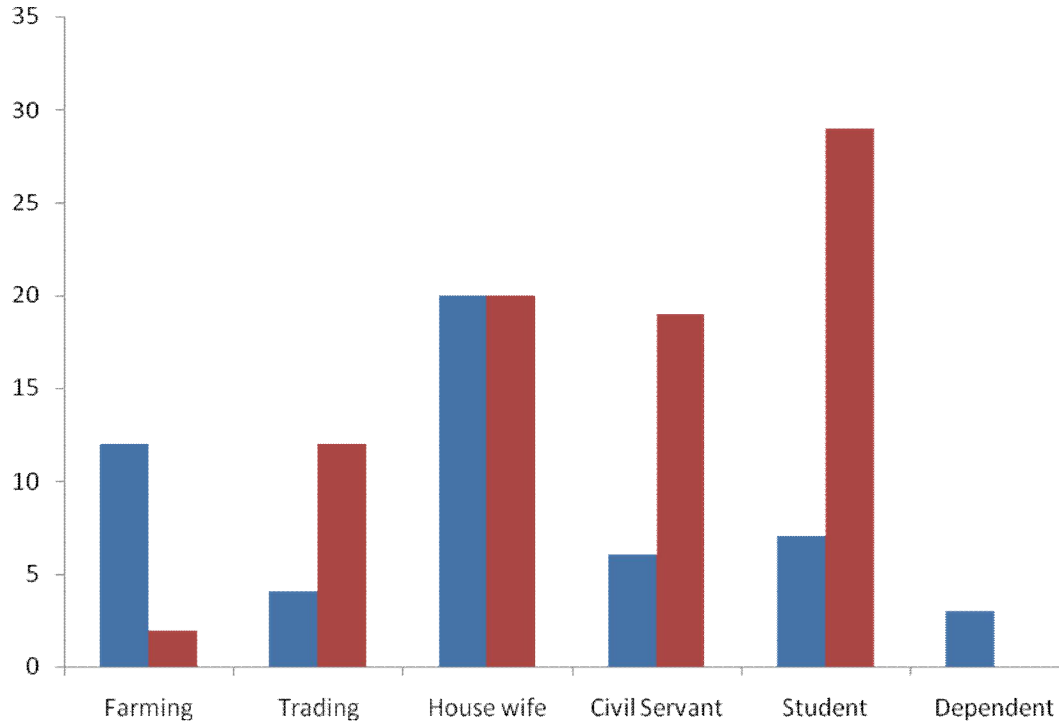


Figure 4.1: Data of keeping of animals by respondents reporting to two hospitals

House wives reported keeping of animals more than any of the groups while students do not appear to be involved in keeping of animals. Most farmers in the hospital groups do keep animals.

Table 4.17: Keeping of animals as an exposure factor for tick infestation among respondents

Keeping of animals	Tick present in environment	Ticks absent in environment	Total
Yes	26	26	52 (35.0%)
No	7	89	96 (65.0%)
Total	33	115	148

Odds ratio is 12.71, 95 % Confidence interval: 4.58-36.66

Keeping of animals is associated with presence of tick in the environment.

Table 4.18: Presence of a tick in the environment as an exposure factor for tick bite among respondents interviewed at the hospitals

Tick present in environment	**History of tick bite Yes**	**History of tick bite No**	**Total**
Yes	1	32	33 (22.3%)
No	2	113	115 (77.7%)
Total	**3**	**145**	**148**

Odds ratio is 1.77, 95% Confidence interval: 0.0-026.05

Presence of ticks in the environment is associated with history of tick bite.

Table 4.19: Risk factors for recurrent fever among respondents

Exposure factor	Odds ratio	95% confidence Interval
Presence of ticks in the environment	2.25	0.74-7.3
Tick bite	0.69	0.10-7.78
Keeping of animals	1.46	0.61-3.51

The exposure factors were associated with recurrent fever but were not statistically significant after multivariate analysis.

4.4 Results of identification of ticks and evaluation for carriers of *Borrelia species*

Ticks were found in soils of resting places, crevices and burrows of trees and wooden poles in livestock markets. Ticks were identified as *Ornithodoros moubata* using gross morphological Characteristic at the Department of Veterinary Parasitology and Entomology Faculty of Veterinary Medicine Ahmadu Bello University Zaria.

All (100 *Ornithodoros moubata)* tick samples tested for the presence of Borrelia by microscopy were negative at 100 magnifications under oil immersion.

CHAPTER FIVE

5.0 DISCUSION

Most participants surveyed in the two hospitals and the three communities were residents of Borno state and were involved in activities/occupation that expose them to tick infestation, tick bite and development of fever as a result of tick bite.

The primary occupation of the study group in the two hospitals and the four communities is related to keeping of animals either directly (rearing of animals and animal trade) or indirectly (civil servant, house wife in houses where animals are kept and dependents of same). Keeping of animals was found to be associated with tick infestation and tick bite in this study. Keeping of animals and animal trade expose people to tick bite by bringing them in close proximity with the vector tick. It is possible that one of those bites could result in infection. When the environment becomes colonized with ticks, infection rate is increased; this is truer in a hot and dry environment such as Borno state. In these arid environments the climatic conditions favours the survival of soft ticks. A study by Fukunaga *et al.,* 1998[88] indicated that in this type of environment, up to 88% of houses in villages could be infested with ticks[90], and more than 60% of these ticks could be carrying *Borrelia* species[88.] Keeping of animals in a particular environment increases the chance of tick infestation because ticks are attracted by their vertebrate by tick.

With increasing desertification in Nigeria the arid region is commensurately expanding thus suitable habitat for survival of *Ornithodoros* ticks covers significant part of northern Nigeria. Changing vector ecology and colonization of new habitat by *Ornithodoros* ticks increases the chances of human and animal contact with ticks.

Ornithodoros ticks were present in all of our study areas located in Kukawa, Baga, Gubio and Damasak and were found to have infested livestock markets and resting places.

In West Africa, geographical distribution of *Borrelia* is classically limited to the Sahel and Saharan regions where the tick vector is distributed. These areas lie in the sahelian vegetation belt of Nigeria which explains why soft ticks are common. Agriculture including livestock production is the major source of livelihood in the Sahelian and sub-Saharan Africa. In these areas there is a large population of livestock species largely raised under free range conditions and considerable population of livestock in these areas are transboundary from neighbouring Niger, Chad and Cameroun republics. Livestock trade is very important to the economy of the people in this region. However, tick infestation is a big menace to livestock production and marketing in the area. This is evidenced by the reportedly rampant infestation of livestock markets with ticks.

Contrary to the reports[89,91] in 2006 that vectors of relapsing fever in the West African region are *Ornithodoros crocidurae* and *Ornithodoros sonrai,* only *Ornithodoros moubata* was identified in the study areas. This is an indication that the possible agent of tick borne relapsing in Nigeria is *Borrelia duttoni* transmitted by *O. moubata*, because *Borrelia* organisms are identified mainly by the identity of their arthropod vector, pathogenicity for laboratory animals and geographical distribution[86].

Ticks were found in soils of resting places, crevices and burrows of trees and wooden poles in livestock markets. This is in conformity with the reports of Sonshine *et al*[26]. The presence of ticks in these places was associated with tick bites; however development of tick borne relapsing fever as a result of the bite was not established. The presence of *O.*

moubata ticks, humans and animal hosts co-existing in this environment is a possibility that borreliosis could be present in the state, because these factors are prerequisite for either human or animal borreliosis,

In this study resting on non cemented/ earth floors during the day was found to be a risk factor for tick bite though not statistically significant. Resting on noncemented/ earth floors is a common practice among the study group. Almost all (97.3%) of these resting places were infested by *O. moubata* which are the principal vector of tick borne relapsing fever in endemic areas[1.]

Ornithodoros ticks have been reported to remain restricted to the habitats of their hosts and rarely move very far. They can be found in loose, dried soil of dwellings, cracks and crevices in mud-walled animal shelters, animal burrows and animal resting places, and under tree bark[82,83].

In this study keeping of animals was found to be a statistically significant risk factor for *O. moubata* infestation. Ticks have a wide host ranging from humans, cattle, sheep, goats, dogs and poultry to camels and this environment has a wide range of these hosts (animals and humans). Tick infestation of premises inhabited by man and animals increases the possibility of contact between *O. Moubata*, animal and human host [(92)]. The epidemiology of tick borne relapsing fever and animal borreliosis are characterised by an intricate set of ecological relationships between the *Borrelia species*, *Ornithodoros species* and the human or animal host. This largely determines the prevalence, spatial and temporal dynamics of these diseases[73].

The risk factors for tick bite in the studies was found to be keeping of animals and sleeping outside at night. Generally, the environmental temperature is usually high making it difficult for people to sleep inside rooms. Combined with the socio-economic conditions of the people, it is usually difficult to acquire cooling systems or build houses that are comfortable. These make people to seek for shed in the day and sleep outside at night. Tick bite increases the possibility of transmission of the organism[72] and infection with relapsing fever *Borrelia* occurs when the host (man or animal) rest or sleep in the vicinity of infected *Ornithodoros* ticks. Ticks are nocturnal feeders and are very sedentary, *O. moubata* transmits relapsing fever *Borrelia* mainly by inoculation of infective saliva and coxal fluid in to the bite wound[93]. Feeding stimulates spirochete multiplication and their number may increase markedly after tick feeding on either infected or uninfected host. Therefore, the act of tick bite is a means of maintaining and propagating *Borrelia* organism and, this contributes greatly in the epidemiology of tick borne relapsing fever, however, the clinical impact of Tick-borne relapsing fever has not yet been explored in Nigeria.

The proportion of people that were bitten by ticks in this study varies in the two study group. Greater percentage of respondents from the community reported more tick bites than those in the referral hospital. This is due to the nature of their environment, housing, socio-economic status and trade. Large proportion of the community respondents are farmers involved in keeping animals, these might have brought them closer to ticks than their counterparts in the referral hospitals. Reports of tick bite is a good source of information for investigating tick borne diseases such as human or animal borreliosis.

Clinical signs of Tick-borne relapsing fever were found in both sexes and in all age groups. Distribution of *Borrelia* in humans varies; *B. recurrentis* predominates in females (60%) while TBRF predominates in males (60%). It is not due to sex or age preference by the organism but probably due to a greater chance of occupational exposure in males[26]. The findings of this study strongly agree with this fact. Males constituted the majority livestock-associated life style.

In TBRF, case fatality rates differ from one geographic complex to another (0-8%). Mortality rate is higher in small children and pregnant women[61] this may not be unrelated to their immune-compromised status where children have not mounted enough immunity to survive the attack. Pregnant women have compromised immunity due to pregnancy. Symptoms of fever, self reported fever and high axillary temperature found in most respondents were in conformity with usual signs of TBRF. Similar findings were reported by M'hammed *et al* 2009[87] who reported that most common signs and symptoms associated with fever were chills (88%), myalgia (61%), and gastrointestinal disorders, such as diarrhoea and vomiting (54%) which we also found in this study. A significant proportion of respondents in this study reported repeated fever ranging from once in a month to as much as more than three times in a month, relapse is one of the major signs of TBRF, consistent with the report of M'hammed *et al* 2009[87] where fifteen percent of the patients reported more than one relapse.

Examination of samples of *O. moubata* hemolymph did not reveal the presence of spirochete. This method is not the most common approach to survey borreliosis in the population. Many workers reported positive cases after examination of blood smears of patients. However, demonstration of the organism in the tick vector is an adjunct to

diagnosis of borreliosis. Where clinical specimens are unavailable or difficult to get like in this study detection of the organism in the tick vector establishes the presence of a viable and hardy reservoir[71]. Perhaps the use of a more sensitive method like detection of *Borrelia* DNA using PCR would have given a better insight in to the true status of *Borrelia* carriage by Ornithodoros ticks in this study. Several authors have described the use of molecular techniques in detecting *Borrelia* organisms in both man, animals and tick vector [(74)]. Therefore the inability of this study to demonstrate Borrelia in the vectors should be interpreted with caution since it is difficult to detect *Borrelia* spirochetes at lower magnification. Other forms of detection techniques such as higher magnification, use of fluorescent microscopy, electron microscopy and nucleic acid detection may give a different detection rate if conducted.

It is important to institute a standard strategy in the control of ticks in this environment, this will help in averting a possible epidemics resulting from tick bite to humans and animals. Methods such as vector control, creating awareness on dangers of tick bite, surveillance for tick borne pathogens would assist in controlling the problem. Further study is required to explore the epidemiology of tick-borne illnesses such as Tick-borne Relapsing Fever.

CHAPTER SIX

6.0 Conclusion And Recommendation

6.1 Conclusion

People living in Borno north senatorial district were engaged in occupation that exposes them to TBRF which are related directly with keeping and trading in animals. Both humans and animals in livestock markets are at risk of tick bites. Also both sexes, young and adult are exposed, with majority of individuals having symptoms of Tick borne relapsing fever being males. The vector of tick borne relapsing fever *Ornithodoros moubata* is the sole colonizing soft tick in tick infested areas of northern Borno.

Ornithodoros moubata infestation is widespread in all the communities studied in northern Borno, contributing to the high number of cases of tick bites reported by more than half the number of respondents that have reported symptoms consistent with tick-borne relapsing fever.

Soils of resting places such as sheds of trees and thatched huts, and the burrows of wooden pillars of such thatched huts are hiding places for the tick vector. Keeping of animals and sleeping outside at night are risk factors for tick infestation of environments and tick bites of household members respectively.

More sensitive methods such as Giemsa stain smears at magnifications of x1000, enzyme-linked immunosorbent assay and or molecular methods would be better for surveillance for Tick borne relapsing fever.

6.2 Recommendations

Based on the study carried out in this area certain recommendations will be made in order to reduce the potential public health implication of TBRF and animal borreliosis in the study areas.

1. Borno state Government should immediately carry out tick de-infestation activities such as spraying of all the livestock markets in the area.
2. Resting places in these livestock markets should be cemented.
3. Public health campaigns about the need to prevent tick bite should be organised in livestock markets of the affected areas.
4. Public health education targeting health care givers working in these areas should be organised in order to sensitize them on the inclusion of Tick Borne Relapsing Fever as a differential of fever related illnesses in their diagnosis.
5. A detailed research should be carried out to determine the epidemiology of TBRF in man, humans and animals in Borno State

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APPENDICES

Appendix 1. *Borrelia* Species Associated With Diseases Of Humans And Animals

S/No	*Borrelia*	Disease	% DNA Homology	Vector	Geographic Distribution Of Disease
1	*B. hermsii*	NW-TBRF	100	*O. hermsi*	Western U.S and Canada
2	*B. turicatae*	NW-TBRF	86	*O. turicatae*	South-western U.S and N. Mexico
3	*B. parkeri*	NW-TBRF	77	*O. parkeri*	Western U.S and Baja California
4	*B. mazzottii*	NW-TBRF	ND	*O. talaje*	Mexico and central America
5	*B. enezuelensis*	NW-TBRF	ND	*O. rudis*	Central America and South America
6	*B. duttoni*	OW-TBRF	17	*O.moubata*	Sub-Saharan Africa
7	*B. crocidurae*	OW-TBRF	32-35	*O.erraticus*	N. Africa, E. Africa, Middle East, East Europe
8	*B. persica*	OW-TBRF	ND	*O.tholozani*	Middle East, Greece, and Central Asia
9	*B. hispanica*	OW-TBRF	ND	*O.morocanus*	Iberian peninsula and western North Africa
10	*B. latyschewii*	OW-TBRF	ND	*O. tartakowskyi*	Iran, Afghanistan, south-central USSR,
11	*B. caucasia*	OW-TBRF	ND	*O. asperus*	Iraq and south-western USSR
12	*B. recurrentis*	LRF	ND	*P. humanus*	Worldwide
13	*B. anserina*	AB	53-63	*A. persicus.*	Worldwide
14	*B.theileri*	BB	ND	*Bo. micro, Bo. annu. Bo.decoloratus R. evertsi*	South Africa, Nig, Australia, Brazil and Mexico
15	*B. burgdorferi*	LD	30-44	*I. dammini*	Eastern United States
				I. ricinus,	Europe, western USSR, and Scandinavia
				I. pacificus	Western United States
16	*B. coriaceae*	EBA	44-50	*0. coriaceus*	California

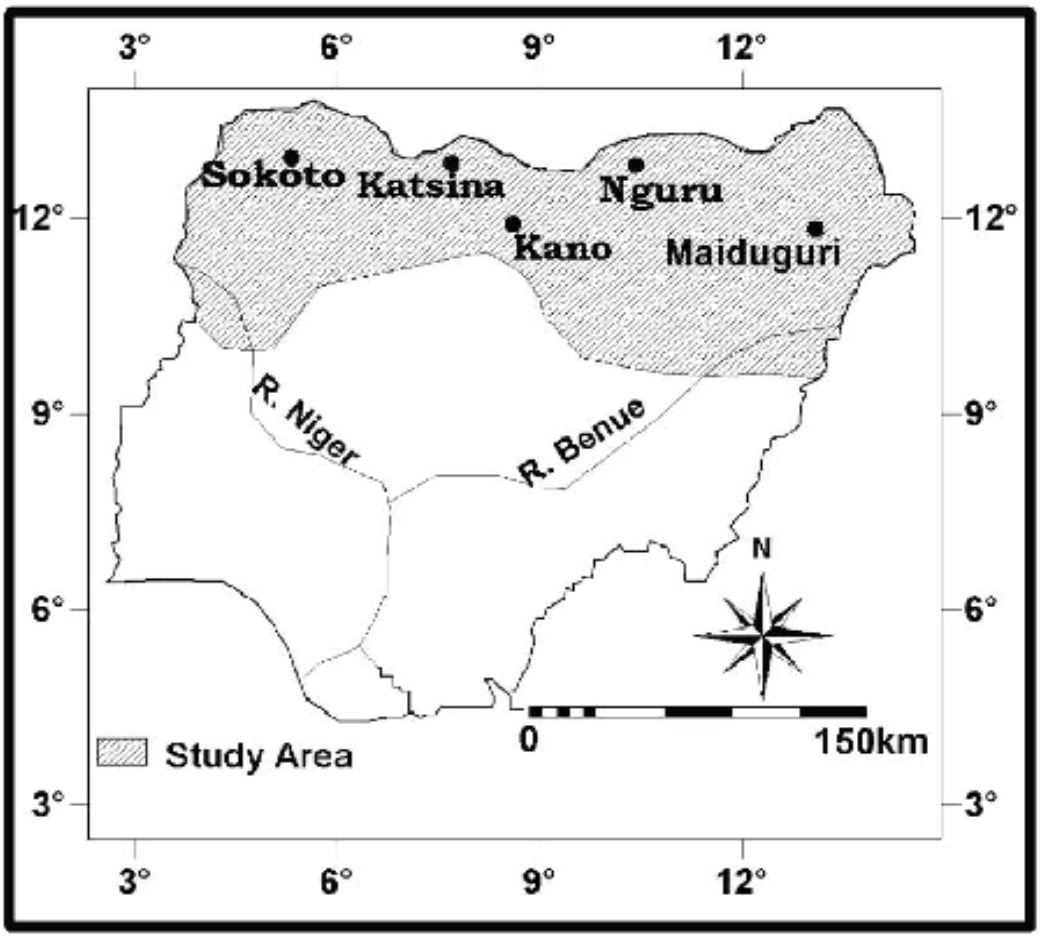
AB= Avian borreliosis, B= Borrelia, Bo= Boophillus, NW-TBRF= New world tick-borne relapsing fever,

OW-TBRF= Old world tick-borne relapsing fever, LRF= Louse borne relapsing fever,

BB= Bovine borreliosis, LD= Lyme disesease, ND= Not determined, O= *Ornithodoros*,

EBA=Epizootic bovine abortion, P= *Pediculus,* A= *Argas,* R=*Rhipicephalus*, I= *Ixodes*,

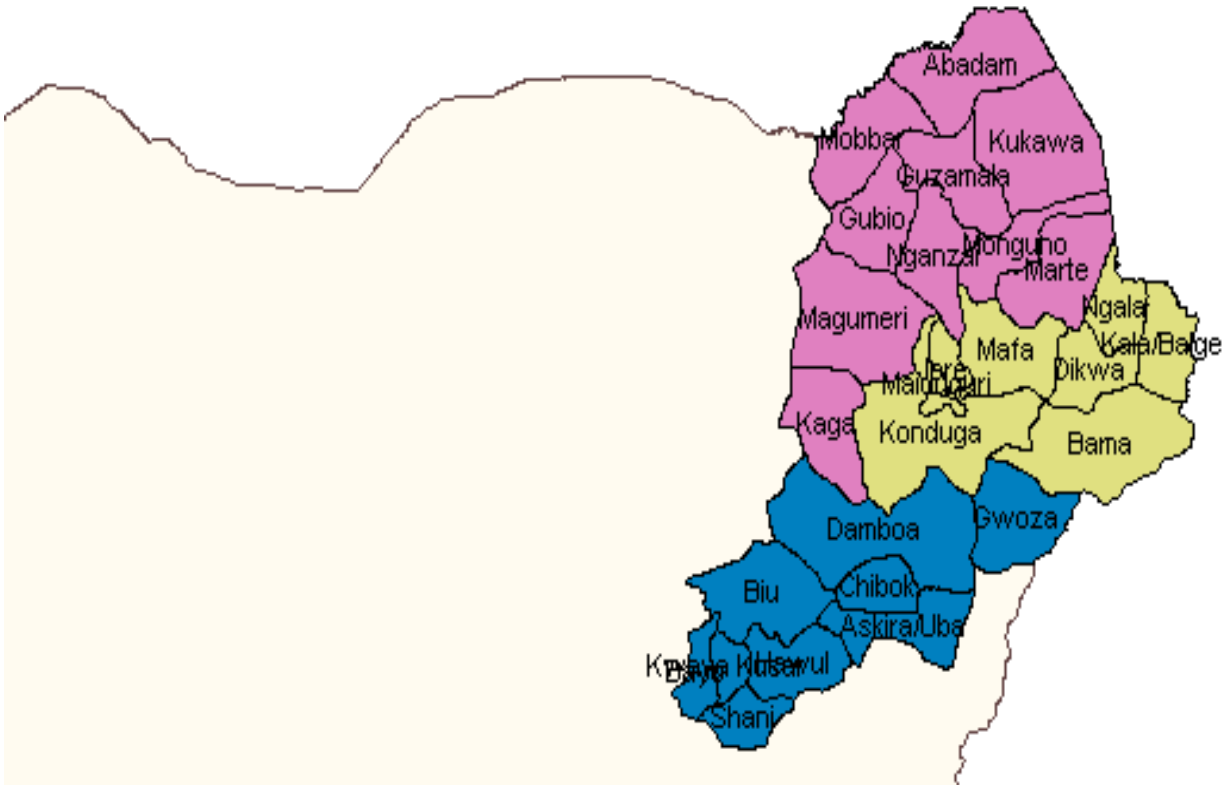
Source: Alan G. Barbour and Stanley F. Hayes (1986). Biology of *Borrelia* Species. Microbiological Reviews, Vol 50 No. 4 p. 381-400.



Appendix 2: Map of Nigeria showing the Sudano-Sahelian ecological zone of the country

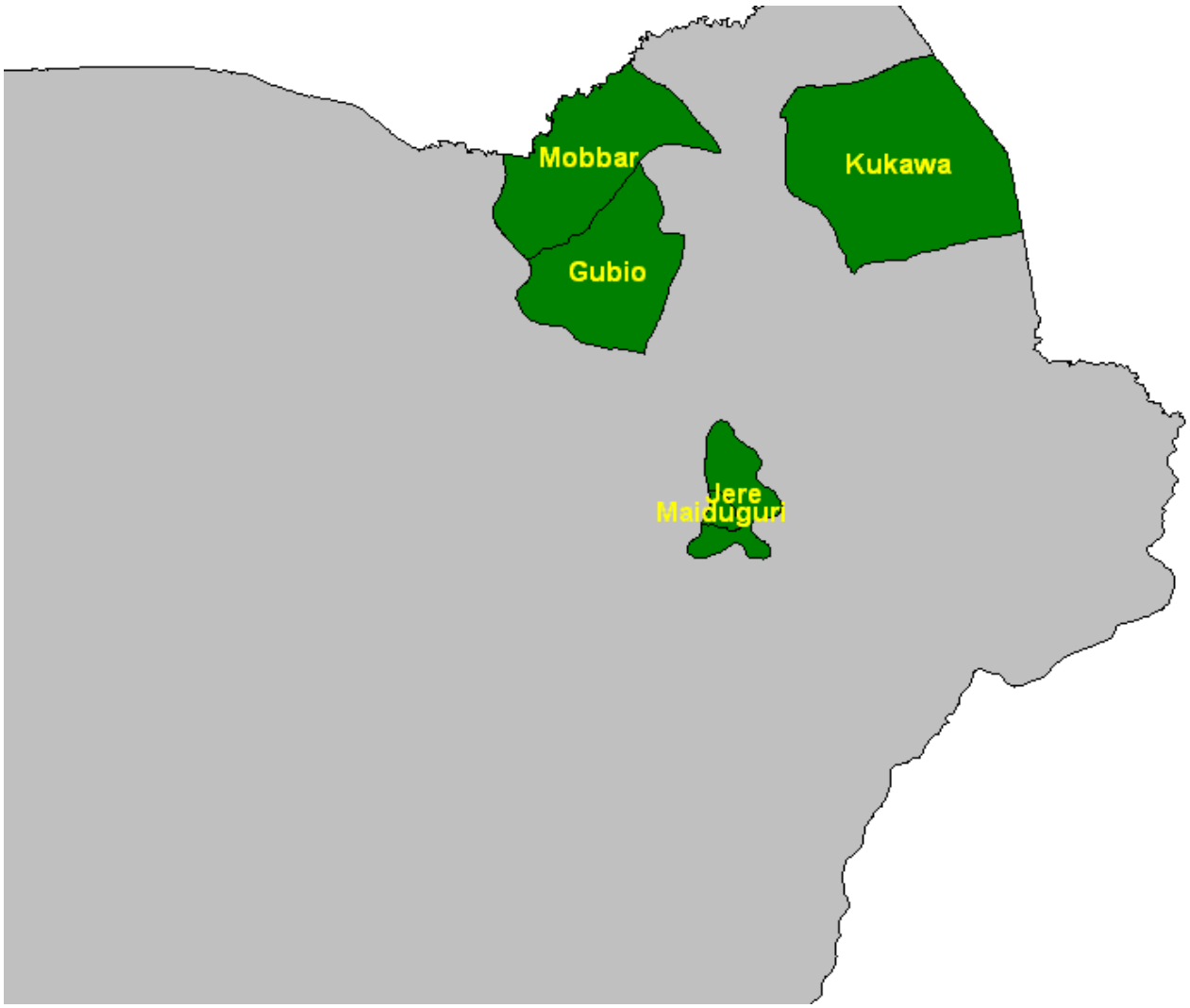


Appendix 3: Map of Nigeria Showing Borno State (Source: Google Images)



Appendix 4: Map of Borno State Showing the Three senatorial districts and 27 local governments

Borno north Senatorial district
Borno central senatorial district
Borno south senatorial district



Appendix 5: Map showing the Study sites

Mobbar, Gubio and Kukawa = Community survey sites

Jere and Maiduguri = Hospital survey sites



Appendix 6: Incubation of *Ornithodoros moubata* at 33^0C in preparation for hemolymph collection



Appendix 7: Preparation of hemolymph smear



Appendix 8: Hand picking of *Ornithodoros moubata* from resting places



Appendix 9: A typical thatched hut (without cemented floor) used by the communities as resting places in the afternoon



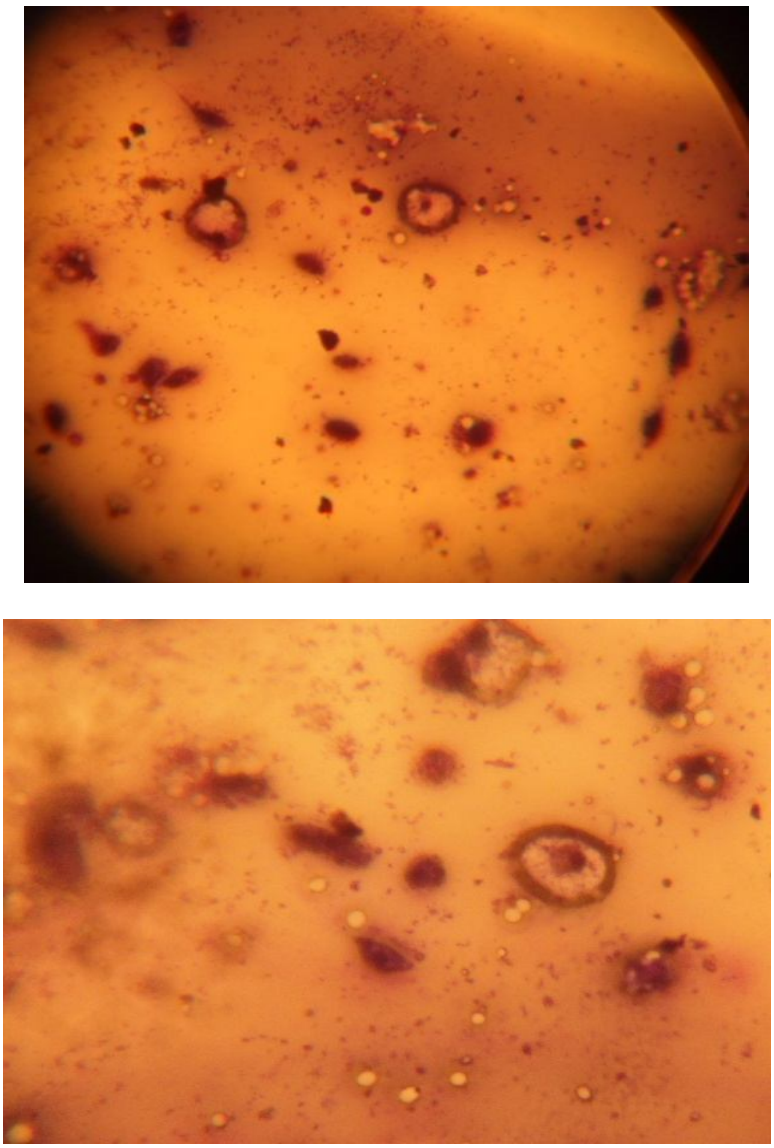
Appendix 10: *Ornithodoros moubata* (arrows) found in burrows and crevices of a tree under which people rest in Gubio cattle Market



Appendix 11: Photograph *Ornithodoros moubata* (Ventral side)



Apeendix 12: *Ornithodoros moubata* (dorsal aspect)



Appendix 13: *Ornithodoros moubata* Hemolymph smear (Giemsa stained X100)

APPENDIX 14
DEMOGRAPHIC FEATURES AND RISK FACTORS ASSOCIATED WITH SUSPECTED CASES OF TICK-BORNE RELAPSING FEVER IN NORTHERN BORNO STATE NIGERIA

HOSPITAL SURVEY

Consent from respondent: We are conducting a study on tick-borne relapsing fever in Borno State; the aim is to determine the proportion of the disease in man, animals and ticks and to identify the risk factors for the disease.
We are requesting your permission to collect your blood sample and then give us the following information which will help in achieving the aim of the study and allow for proper planning of intervention. All information will be confidential and used for the purpose of this study only. Your participation is optional
Thank you.

Questionnaire Number…… **Date of interview……..**

Interviewer……

Hospital …….

GPS: Longitude …… Latitude ……..

A. Patient Demographic Information

Name……

Sex …….

Age …….

Community……..

Ward/LGA……

Occupation……..

B. Clinical Information

1. Body temperature (^{0}C)…….

2. Do you have any of the following fever-related symptoms?
   - Hot body feeling [ ]
   - Vomiting [ ]
   - Headache [ ]

3. How often is your fever in a year?
   - None [ ]
   - Once [ ]
   - Twice [ ]
   - Three times [ ]
   - More than three times. [ ]

4. How often is your fever in a month?
   - None [ ]
   - Once [ ]
   - Twice [ ]
   - More than twice [ ]
   - Almost every day

5. Have you ever been treated for the fever? Yes [ ] No [ ]
6. Have you ever been treated for the fever? Yes [ ] No [ ]

7. Do you keep animals? Yes [ ] No [ ]

8. Do you associate with animals in any way? Yes [ ] No [ ]

9. **IF YES** in question 6 above, what type of animal? Tick all that is applicable
   - Cattle [ ]
   - Camel [ ]
   - Sheep [ ]
   - Goat [ ]
   - Dog [ ]
   - Poultry [ ]

10. **IF YES** in question 7 above, specify the form of association.
    - Grooming [ ]
    - Feeding [ ]
    - Selling/buying [ ]
    - Others (Specify)…….

11. Do you have ticks in your environment (Market/house)? Yes [ ] No [ ] Don't know [ ]

12. Have you ever been bitten by a tick? Yes [ ] No [ ] Don't know [ ]

Appendix 15
DEMOGRAPHIC FEATURES AND RISK FACTORS ASSOCIATED WITH SUSPECTED CASES OF TICK-BORNE RELAPSING FEVER IN NORTHERN BORNO STATE NIGERIA

COMMUNITY HEALTH CENTRE SURVEY

Consent from respondent: We are conducting a study on tick-borne relapsing fever in Borno State; the aim is to determine the proportion of the disease in man, animals and ticks and to identify the risk factors for the disease.
We are requesting your permission to give us the following information which will help in achieving the aim of the study and allow for proper planning of intervention. All information will be confidential and used for the purpose of this study only. Your participation is optional
Thank you.

Questionnaire Number---------- Date ----------

A. **Demographic information**

1. Sex ------- Age ------ Village…….. …. Local government --------

2. Primary Occupation
   Farmer [ ]
   Civil servant [ ]
   Business /trading [ ]
   Herdsman [ ]
   Other

3. House type
   Mud (hut) [ ]
   Cemented house [ ]
   Others [ ]

4. Do you keep animals? YES [ ] NO [ ]

   If yes, state the animal type.

   Camel [ ]
   Cattle [ ]
   Sheep /Goat [ ]
   Poultry [ ]
   Dog [ ]
   Others [ ]

D. How far is your animal housing/stable from your house?
   They are kept in the house. [ ]
   50mtrs [ ]
   100mtrs [ ]
   200mtrs [ ]
   Others [ ]

E. Do you have rodents in your compound? Yes [ ] No [ ]
If yes, what type of rodent?
Rat [ ]
Mice [ ]
Others [ ]

F. Where do you rest in the afternoon?
Shed (e.g. under a tree) [ ]
On cemented floor [ ]
Others. [ ]

G. How far is your resting place from the animal stable?
20-40mtrs [ ]
50-100mtrs [ ]
>100mtrs [ ]

H. Do you sleep outside at night? Yes [ ] No [ ]

I. Have you ever had a fever ? Yes [ ] No [ ]

J. Do you have fever? Yes [ ] No [ ]

K. How often is your fever in a month?

Not at all [ ]
Once [ ]
Twice [ ]
More than twice [ ]

I. How often is your fever in a year?
Not at all [ ]
Once [ ]
Twice [ ]
Three times [ ]
More than three times [ ]

M. Have you ever been treated for the fever? Yes [ ] No [ ]

N. Do you have ticks in your environment (Market/house)? Yes [ ] No [ ]

O. Have you ever been bitten by a tick? Yes [ ] No [ ]

P. Did any of your family member ever been bitten by a tick? Yes [ ] No [ ]

Appendix 16

UNIVERSITY OF MAIDUGURI TEACHING HOSPITAL

Chairman Board of Management
Prof. Sadiq S. Wali, OFR
FRCP (London; FWACP; FMCP; DTPH

Director of Administration
Babagana M. Aji, B.Ed; MPA

Chief Medical Director
Prof. A. Tahir, FWACS; FMCR; FAMS

Chairman Medical Advisory Committee
DR. M.B. Tahir, FWACS

P.M.B 1414 Bama Road, Maiduguri, Nigeria
E-mail: cmd_umth@yahoo.com

ADM/TH/746/VOL.1

18TH/04/2011

The Program Director, NFELTP
Department of Public Health
Federal Ministry of Health,
PMB 083, Abuja.
Nigeria.

Dear Sir,

RE: EPIDEMIOLOGY OF TICK-BORNE RELAPSING FEVER IN BORNO STATE CROSS-SECTIONAL STUDIES IN HUMANS, ANIMALS AND TICKS

I write to acknowledge the receipt of your letter dated 13th April, 2011 introducing Dr. Jibrin Idris Manu and also requesting the Hospital to support him in carrying out a study on the topic mentioned above.

I am directed to inform you that, the Chief Medical Director has approved your request for Dr. Jibrin Idris Manu to conduct the study in the Hospital Departments of Medicine and Paediatrics on the topic mentioned above.

Please accept our best regards.

Yours faithfully,

ISHAQ ABDULLAHI
FOR: Chief Medical Director

Appendix 17

UNIVERSITY OF MAIDUGURI TEACHING HOSPITAL

Chairman Board of Management
Prof. Sadiq S. Wali, OFR
FRCP (London); FWACP; FMCP; DTPH

Director of Administration
Babagana M. Aji; B.Ed; MPA

Chief Medical Director
Prof. A. Tahir, FWACS; FMCR; FAMS

Chairman Medical Advisory Committee
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P.M.B. 1414 Bama Road, Maiduguri, Nigeria
E-mail: cmd_umth@yahoo.com

Our Ref: ADM/TH/75/Vol.III

26/4/2011.

Idris Jibrin Manu
Nigerian Field Epidemiology
and Laboratory Training Program,
Epidemiology Division,
Department of Public Health
Federal Ministry of Health Abuja,
MPH/MED/0001/2008-2001.

RE: REQUEST FOR ETHICAL CLEARANCE RESEARCH PROPOSAL EPIDEMIOLOGY OF TICK-BORNE RELAPSING FEVER IN BORNO STATE: CROSS-SECTIONAL STUDIES IN HUMANS, ANIMALS AND TICKS.

With reference to your letter dated 26/4/2011. On the above subject matter.

That after careful review of your research proposal by the Research and Ethical Committee, approval is hereby given.

Good luck.

Babale Garba Nafada
Sec. Research & Ethical Committee.